The Titania Monofin

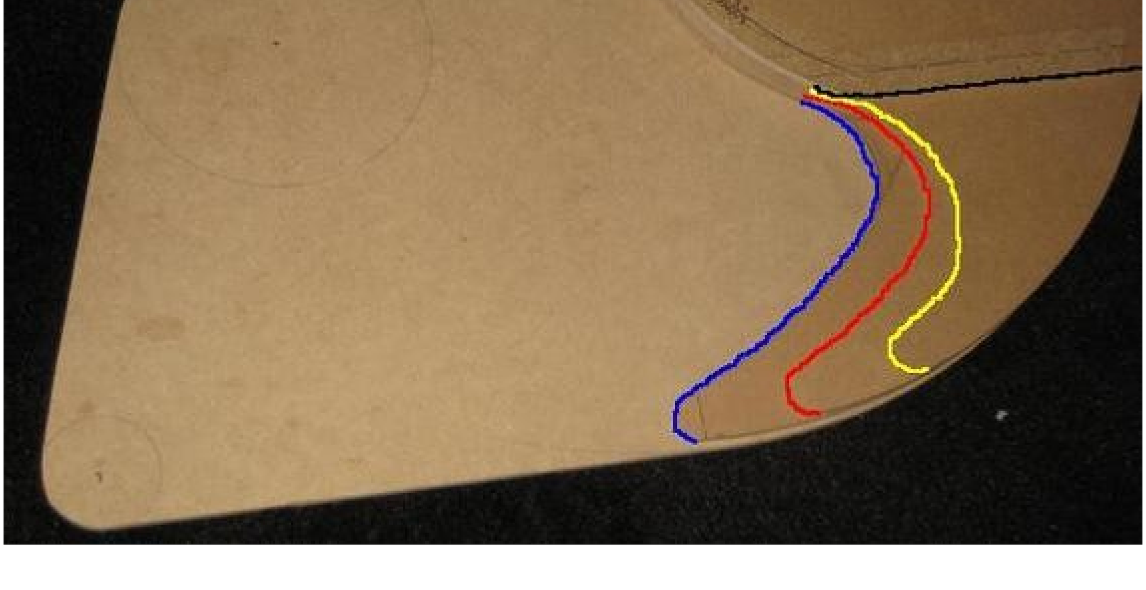
Editors Note: This how-to is copied from a forum post, accounting for some of the strange formatting. The creator of this how-to is a poster named “Capt Nemo”.

Here's a few pics and info on Titania's monofin.

I first wanted a better mono than my Rapid, cause it hurt my feet. I also wanted this for a mertail. The first prototype was built of polycarbonate and acrylic. I knew the polycarbonate was damn near unbreakable but too soft for swimming without stiffening. I built the stiffeners out of 1/4" plexiglass and screwed everything together. The footpockets for the fin are red gasket rubber. The bottom plate and footpocket holding plate are also polycarbonate. I did that to prevent cutting my foot if it snaps during swimming.

Swimming tests went pretty well! When you really kick the polycarbonate blade really snaps shooting you through the water. However, the acrylic stiffeners cracked through the screw hole from the force of the polycarbonate blade. You could almost see the blade do almost 90 degrees at the stiffener on a hard kick. I've seen carbon fiber and fiberglass do almost the same, and sometimes snap in about the same area. The polycarbonate looked fine. I bent a piece of poly to see how it would fail, and it almost had to be folded over on itself before it whitened, and the whitened area had to be worked a few times before it broke with no sharp edges. So the blade seems to be excellent, and the stiffeners need work.

I decided to make the stiffeners out of polycarbonate and try again. Between the two, I found out that polycarbonate can be solvent welded with methelene chloride the same as acrylic. YES! NO MORE SCREWS! I set to work making router patterns rather than cutting each out on the bandsaw and sanding to shape. The design would use three stiffeners of differnt sizes on one side of the blade, with the smallest being the footpocket bottom. The other side of the blade would get two and the top plate to hold the rubber to the fin. The stiffeners are laid out in the same manner as blade root construction in helicopter blades. This would make a strong footpocket area, and gradually soften out to the sides. I made this blade a little smaller due to the price of polycarbonate doubleing. What was $30 was now $60. Here's the hardboard router patterns. I added the color so you could see the build up.



Once the patterns were ready, I began cutting the poly with the router. I used a 1/4" id guide insert and a 1/4" straight bit on the router. I had to cut the top plate on the bandsaw as the pattern was too flexible for the router. After cutting, the pieces needed deburring before welding in place. Some 240 grit sandpaper took care of that. Also sand all interior curves smooth. After sanding strip the protective layers on all pieces and wash them to remove fingerprints and any debris.

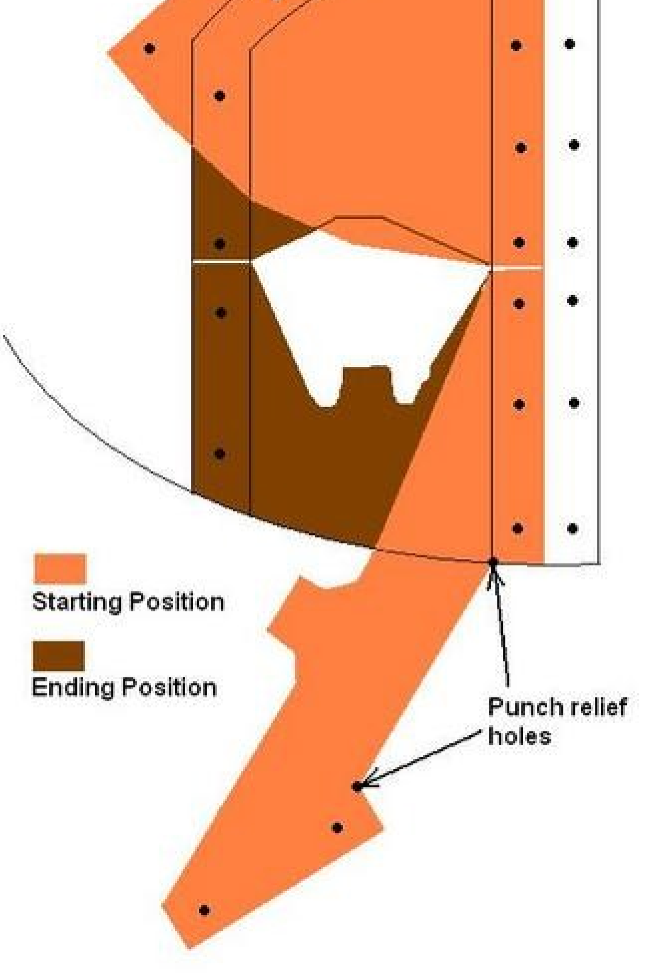
Solvent welding seems easy, but to get a clear joint in polycarbonate pressure is needed. You will need a plexiglass welding bottle and large gauge needle. The bottle can be found in some hardware stores along with the methelene chloride. The kit needles are too small. Go to a farm store and get a pack of 18-20 gauge needles and cut the tips off. You will have to file the tips open again after cutting. Stick the needle into something desposable before cutting to control that razor sharp chunk of nastiness! Have 7-8 Quick Grip bar clamps ready as this process needs to go quickly.

Take the first stiffener and position it, and clamp it in the middle and one side. Flip the blade over so that the smaller piece is on the bottom. on the loose end squirt a little solvent on the surface to be bonded and bring the pieces together and clamp. You will see the solvent spread out between the pieces. Break the other two clamps, and begin squirting more solvent between the pieces and clamping every few inches. Keep the solvent flowing evenly with no gaps in coverage. If solvent gets where you don't want it, DONT TRY AND WIPE IT UP. It will disfigure the plastic worse than without. If you get some bubbles or milkiness, it may look bad but but it is still strong. Getting it clamped right away is key. The more even pressure the better. Also don't try going back to get a bubble, you will only make more. After the weld, give it 30 minutes in the clamps. Continue until the first four stiffeners are in place. If it's perfectly clear and no bubbles or other disfigurements, GOOD JOB! YOUR A PRO!

Now cut the footpockets out and drill and tap the blade for the screws to hold the rubber pockets in place. I used stainless 5/8" truss head screws. Use a jigsaw and fresh plastics blade. Sand the pockets smooth. Wash the blade again to remove any debris. Solvent weld the bottom plate/stiffener. Sand all the outside edges smooth.

I chose to go with a two piece rubber binding instead of the one piece, to improve the heel strap. I wanted the binding more like a waterski binding. The bindings use 1/8" red gasket rubber 12"x12". (the next rendition will use silicone)   To begin, take a sheet and layout and punch holes for the screws only on the side that will be on the inside of the binding. Next screw the rubber and top plate down. Put on a 1mm neoprene sock, and stick foot into the pocket of the fin. Pull the rubber under the top plate until your foot is snug but comfortable. Mark the screw hole positions, and a trim line with the top plate pressed firmly against the blade body. Trim the excess enough to punch the holes but leave some sticking out. Now screw the top plate and rubber down. With a razor knife trim the excess rubber sticking out past the top plate. Remove the rubber toe pocket and use it to make another rough copy for the other side. Keep the outside edge long and verify the screw holes before punching and final trimming.

The heel strap is kind of a weird piece that needs a lot of work to get right. I ran thru a number of angles and rubber before I got it right. The pic below gives an idea of what both pieces look like flat, and in position. A heel tab is a nice addition for getting into the fin. You will have to trim the pocket openings to get it to fit right.



And here's the fin covered in spandex. Depending on the covering material, the fin can look translucent, or transparent.

Thank you so much for sharing this. It's such a great design! It looks like its really strong, and probably very effective in the water. And the foot pocket design is awesome too. For the monofin I made I used straps going through slits in an aluminum plate, which worked okay, but I imagine the gasket rubber would work a lot better.

So in the final version did you use any acrylic at all, or did you only use polycarbonate for the fin and for the stiffeners?

The entire fin is polycarbonate. The way solvent welding works is, it loosens the bonds in the plastic, and when it evaporates, the bonds knit together completely. So the joint is one solid piece of plastic with no junction between the two pieces. Acyrlic and polycarbonate have different bonding sites, so they won't weld.

Edit: A 48" x 48" sheet of .091 Lexan (polycarbonate) will make one fin. Minimum rubber needed, 2 X 12"x12" sheets. I also found some silicone rubber aviation door seal that I want to test on the next one I build.

I just built a second fin from the patterns. I had a little problem this time with the router jumping and gouging the patterns leading to a few nicks, but nothing serious. Welding still is bubbly and cloudy, but solid. It's hard to get the pieces clamped in time, welding goes that fast!!! Somehow the footpocket layout is got skewed about 3/8". I'll probably have to do some adjustments on the heel pockets yet.